CAN END AND METHOD FOR FIXING THE SAME TO A CAN BODY

This invention relates to an end wall for a container and more particularly but not exclusively to an end wall of a can body and a method for fixing the end wall to the can body by means of a double seam.

US Patent 4093102 (KRASKA) describes can ends comprising a peripheral cover hook, a chuck wall dependent from the interior of the cover hook, an outwardly concave annular re-inforcing bead extending radially inwards from the chuck wall and a central panel joined to an inner wall of the reinforcing bead by an annular outwardly convex bead. This can end is said to contain an internal pressure of 90psi by virtue of the inclination or slope of the chuck wall, bead outer wall and bead inner wall to a line perpendicular to the centre panel. The chuck wall slope D° is between 14° and 16°, the outer wall slope E is less than 4° and the inner wall slope C° is between 10 and 16° leading into the outwardly convex bead. We have discovered that improvements in metal usage can be made by increasing the slope of the chuck wall and limiting the width of the anti peaking bead.

US Patent 4217843 (KRASKA) describes an alternative design of can end in which the countersink has inner and outer flat walls, and a bottom radius which is less than three times the metal thickness. The can end has a chuck wall extending at an angle of approximately 24° to the vertical. Conversely, our European Patent application EP0340955A describes a can end in which the chuck wall extends at an angle of between 12° and 20° to the vertical.

Our European Patent No. 0153115 describes a method of making a can end suitable for closing a can body

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containing a beverage such as beer or soft drinks. This can end comprises a peripheral flange or cover hook, a chuck wall dependant from the interior of the cover hook, an outwardly concave reinforcing bead extending radially inwards from the chuck wall from a thickened junction of the chuck wall with the bead, and a central panel supported by an inner portion of the reinforcing bead. Such can ends are usually formed from a prelacquered aluminium alloy such as an aluminium magnesium manganese alloy such as alloy 5182.

Our International Patent Application published no. WO93/17864 describes a can end suitable for a beverage can and formed from a laminate of aluminium/manganese alloy coated with a film of semi crystalline thermoplastic polyester. This polyester/aluminium alloy laminate permitted manufacture of a can end with a narrow, and therefore strong reinforcing bead in the cheaper aluminium manganese alloy.

These known can ends are held during double seaming by an annular flange of chuck, the flange being of a width and height to enter the anti-peaking bead. There is a risk of scuffing if this narrow annulus slips. Furthermore a narrow annular flange of the chuck is susceptible to damage.

Continuing development of a can end using less metal, whilst still permitting stacking of a filled can upon the end of another, this invention provides a can end comprising a peripheral cover hook, a chuck wall dependant from the interior of the chuck wall, an outwardly concave annular reinforcing bead extending radially inwards from the chuck wall, and a central panel supported by an inner portion of the reinforcing bead,

characterised in that, the chuck wall is inclined to an axis perpendicular to the exterior of the central panel at an angle between 30° and 60°, and the concave bead narrower than 1.5mm (0.060"). Preferably, the angle of the chuck wall to the perpendicular is between 40° and 45°.

In a preferred embodiment of the can end an outer wall of the reinforcing bead is inclined to a line perpendicular to the central panel at an angle between -15° to +15° and the height of the outer wall is up to 2.5mm.

In one embodiment the reinforcing bead has an inner portion parallel to an outer portion joined by said concave radius.

The ratio of the diameter of the central panel to the diameter of the peripheral curl is preferably 80% or less.

The can end may be made of a laminate of thermoplastic polymer film and a sheet aluminium alloy such as a laminate of a polyethylene teraphthalate film on an aluminium - manganese alloy sheet or ferrous metal typically less than 0.010 (0.25mm) thick for beverage packaging. A lining compound may be placed in the peripheral cover hook.

In a second aspect this invention provides a method of forming a double seam between a can body and a can end according to any preceding claim, said method comprising the steps of:-

placing the curl of the can end on a flange of a can body supported on a base plate, locating a chuck within the chuck wall of the can end to centre the can end on the can body flange, said chuck having a frustoconical

drive surface of substantially equal slope to that of the chuck wall of the can end and a cylindrical surface portion extending away from the drive surface within the chuck wall, causing relative motion as between the assembly of can end and can body and a first operation seaming roll to form a first operation seam, and thereafter causing relative motion as between the first operation seam and a second operation roll to complete a double seam, during these seaming operations the chuck wall becoming bent to contact the cylindrical portion of the chuck.

Various embodiments will now be described by way of example and with reference to the accompanying drawings in which:-

Figure 1 is a diagrammatic sketch of known apparatus for forming a double seam;

Figure 2 is an enlarged sectioned side view of a known chuck and can end before seaming;

Figure 3 is a sectioned view of a fragment of a known double seam;

Figure 4 is a sectioned side view of a can end according to this invention before edge curling;

Figure 5 is a sectioned side view of the can end of Figure 4 on a can body before forming of a double seam;

Figure 6 is a like view of the can end and body during first operation seaming;

Figure 7 is a like view of the can end and body during final second operation seaming to create a double seam;

Figure 8 is a fragmentary section of a chuck detail; and

Figure 9 is a side view of the cans stacked one on the other.

In Figure 1, apparatus for forming a double seam comprises a base plate 1, an upright 2 and a top plate 3. A lifter 4 mounted in the base plate is movable towards and away from a chuck 5 mounted in the top plate. The top plate supports a first operation seaming roll 6 on an arm 7 for pivotable movement towards and away from the chuck. The top plate also supports a second operation seaming roll 8 on an arm 9 for movement towards and away from the chuck after relative motion as between the first operation roll and can end on the chuck creates a first operation seam.

As shown in Figure 1 the chuck 5 holds a can end 10 firmly on the flange 11 of a can body 12 against the support provided by the lifter plate 4. Each of the first operation roll 6 and second operation roll 7 are shown clear of chuck before the active seam forming profile of each roll is moved in turn to form the curl of the can end and body flange to a double seam as shown in Figure 3.

Figure 2 shows on an enlarged scale the chuck 5 and can end 10. The can end comprises a peripheral curl 13, a chuck wall 14 dependent from the interior of the curl, an outwardly concave anti-peaking bead 15 extending inwards from the chuck wall to support a central panel 16. Typically the chuck wall flares outwardly from the vertical at an angle C about 12° to 15°.

The chuck 5 comprises a body 17 having a threaded bore 18 permitting attachment to the rest of the apparatus (not shown). An annular bead 19 projects from the body 17 of the chuck to define with the end face of

the body a cavity to receive the central panel 16 of the can end. The fit of panel 16 in annulus 19 may be slack between panel wall and chuck.

The exterior surface of the projecting bead 19 extends upwards towards the body at a divergent angle B of about 12° to the vertical to join the exterior of the chuck body 17 which tapers off an angle A° of about 4° to a vertical axis perpendicular to the central panel. The outer wall of the chuck 5 engages with the chuck wall at a low position marked "D" within the 12° shaped portion of the chuck bead 19.

As can ends are developed with narrower anti-peaking beads the chuck bead 19 becomes narrower and more likely to fracture. There is also a risk of scuffing of the can end at the drive position D which can leave unacceptable unsightly black marks after pasteurisation.

Figure 3 shows a sectioned fragment of a typical double seam showing a desirable overlap of body hook 21 and end hook 20 between the can end 10 and can body 12.

Figure 4 shows a can end, according to the invention, comprising a peripheral cover hook 23, a chuck wall 24 extending axially and inwardly from the interior of the peripheral cover hook, an outwardly concave reinforcing or anti-peaking bead 25 extending radially inwards from the chuck wall, and a central panel 26 supported or an inner portion panel with 27. The panel wall is substantially upright allowing for any metal spring back after pressing. The chuck wall is inclined to an axis perpendicular to the exterior of the central panel at an angle C between 20° and 60°; preferably between 40° and 45°. Typically the cross sectional radius of the antipeaking bead is about 0.5mm.

Preferably the anti-peaking bead 25 is parallel sided, however the outer wall may be inclined to a line perpendicular to the central panel at an angle between -15° to +15° and the height h_4 of the outer wall may be up to 2.5mm.

This can end is preferably made from a laminate of sheet metal and polymeric coating. Preferably the laminate comprises an aluminium magnesium alloy sheet such as 5182, or aluminium manganese alloy such as 3004 with a layer of polyester film on one side. A polypropylene film may be used on the "other side" if desired.

Typical dimensions of the example of the invention are:-

d5	overall diameter (as stamped)	65.83mm
d4	PC diameter of seaming panel radius	61.54mm
d3	PC diameter of seaming panel/chuck wall radius	59.91mm
r_1	seaming panel/chuck wall radius	1.27mm
r_2	seaming panel radius	5.56mm
r_3	concave radius in antipeaking bead	<1.5mm
d_2	maximum diameter of antipeaking bead	50.00mm
d_1	minimum diameter of antipeaking bead	47.24mm
h_2	overall height of can end	6.86mm
h_1	height to top of antipeaking bead	5.02mm
h_3	panel depth	2.29mm
h_4	outer wall height	1.78mm
c	chuck wall angle to vertical	43°

From these dimensions it can be calculated that the ratio of central panel diameter of 47.24mm to overall diameter of can end 65.84 is about 0.72 to 1.

For economy the aluminium alloy is in the form of sheet metal less than 0.010" (0.25mm). A polyester film on the metal sheet is typically 0.0005" (0.0125mm).

Although this example shows an overall height h at 6.86mm we have also found that useful can ends may be made with an overall height as little as 6.35mm (0.25").

Figure 5 shows the peripheral flange 23 of can end 22 of Figure 4 resting on the flange 11 of a can body 12 before formation of a double seam as discussed with reference to Figure 1.

In Figure 5 a modified chuck 30 comprises a chuck body 31 having a frustoconical drive surface 32 engaging with the chuck wall 24 of the can end 22.

The frustoconical drive surface is inclined outwardly and axially at an angle substantially equal to the angle of inclination C° of between 20° and 60°; in this particular example on chuck angle C of 43° is preferred. The drive surface 32 is a little shorter than the chuck wall 24 of the chuck body. The substantially cylindrical surface portion 33, rising above the drive surface 32, may be inclined at an angle between +4° and -4° to a longitudinal axis of the chuck. As in Figure 2, this modified chuck 30 has a threaded aperture to permit attachment to the rest of the double seam forming apparatus (not shown).

In contrast to the chuck of Figure 2 the modified chuck 30 is designed to drive initially on the relatively large chuck wall 32 without entering deeply into the anti-peaking bead 25. Further drive is obtained at the

juncture of chuck wall 32 and cylindrical wall 33 as chuck wall of end 24 is deformed during 1st and 2nd operation seaming Figure 6 and 7. The chuck 30 shown in Figure 5 has an annular bead of arcuate cross section but this bead is designed to enter the chuck wall without scratching or scuffing a coating on the can end; not to drive on the concave bead surface as shown in Figure 2.

It will be understood that first operation seaming is formed using apparatus as described with reference to Figure 1.

Figure 6 shows the modified can end and chuck during formation of a first operation seam shown at the left of Figure 2 as formed by a first operation roll 34 adjacent the interfolded peripheral flange of the can end and flange 11 body 12.

During relative rotation as between the can end 22 and first operation roll 34 the edge between the chuck drive wall 32 and cylindrical wall 33 exerts a pinching force between chuck 30 and roll 34 to deform the chuck wall of the can end as shown.

After completion of the first operation seam the first operation roll is swung away from the first operation seam and a second operation roll 38 is swung inwards to bear upon the first operation seam supported by the chuck 30. Relative rotation as between the second operation roll 38 and first operation seam supported by a chuck wall 30 completes a double seam as shown in Figure 7 and bring the upper portion 24 of the chuck wall 24 to lie tightly against the can body neck in a substantially upright attitude as the double seam is tightened by pinch pressure between the second operation roll 38 and chuck 30.

Can ends according to the invention were made from aluminium alloy 5182 and an aluminium alloy 3004/polymer laminate sold by CarnaudMetalbox under the trade mark ALULITE. Each can end was fixed by a double seam to a drawn and wall ironed (DWI) can body using various chuck angles and chuck wall angle as tabulated in Table 1 which records the pressure inside a can at which the can ends failed:-

TABLE 1

SAMPLE CODE	CAN END DATA			PRESSURE IN BAR (PSIG) TO FAILURE FOR VARIOUS SEAMING CHUCK ANGLES B°				
	MATERIAL Thickness mm	MINIMUM Diameter D1 mm	CHUCK WALL ANGLE "C"	23°	10°/23°	4°/23°	23° WITH D. SEAM RING	10°/23° WITH D. SEAM RING
A	ALULITE 0.23	52.12 (2.052")	21.13°	5.534 (80.20)	5.734 (83.10)	5.311 (76.97)	6.015 (87.17)	5.875 (85.14)
B	5182 0.244	52.12 (2.052")	21.13°	5.599 (81.15)	5.575 (80.79)	5.381 (77.99)	5.935 (86.01)	5.895 (85.43)
C	5182 0.245	52.12 (2.052")	21.13°	6.004 (87.02)	5.910 (85.65)	5.800 (84.06)	6.224 (90.21)	6.385 (92.54)
D	ALULITE 0.23	51.92 (2.044")	21.13°	5.334 (77.31)	5.229 (75.78)	5.238 (75.91)	5.730 (83.04)	5.404 (78.32)
E	5182 0.224	51.92 (2.044")	21.13°	5.555 (80.50)	5.514 (79.92)	5.354 (77.60)	5.895 (85.43)	5.930 (85.94)
F	5182 0.245	51.92 (2.044")	23°	5.839 (84.63)	5.804 (84.12)	5.699 (82.59)	6.250 (90.58)	6.435 (93.26)
G	ALULITE 0.23	51.92 (2.044")	23°			5.123 (74.25)		
H	5182 0.224	(51.92) (2.044")	23°			5.474 (79.34)		
I	5182 0.245	51.92 (2.044")	23°			5.698 (82.58)		

All pressures on unaged shells in bar (psig). 5182 is an aluminium-magnesium-manganese alloy lacquered. The "ALULITE" used is a laminate of aluminium alloy and polyester film.

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The early results given in Table 1 showed that the can end shape was already useful for closing cans containing relatively low pressures. It was also observed that clamping of the double seam with the "D" seam ring resulted in improved pressure retention. Further tests were done using a chuck wall angle and chuck drive surface inclined at nearly 45°: Table 2 shows the improvement observed:-

Table 2

Sample Code	h_2 mm(inches)	h_3 mm(inches)	h_4 mm(inches)	Chuck Angles B° 43°	43° with seam ring
J	6.86(0.270)	2.[illegible](0.094)	2.29(0.09)	4.89(70.9)	6.15 (89.1)
K	7.11(0.280)	2.[illegible](0.104)	2.54(0.10)	4.83(70.0)	5.98 (86.6)
L	7.37(0.290)	2.[illegible](0.114)	2.79(0.11)	4.74(68.7)	6.44 (93.3)

Table 2 is based on observations made on can ends made of aluminium coated with polymer film (ALULITE) to have a chuck wall length of 5.029mm (0.198") up the 43° slope.

It will be observed that the container pressures achieved for samples J, K, L, 4.89 bar (70.9 psig), 4.83 bar (70.0 psig) and 4.74 bar (68.7 psig) respectively were much enhanced by clamping the double seam.

In order to provide seam strength without use of a clamping ring, modified chucks were used in which the drive slope angle C° was about 43° and the cylindrical surface 33 was generally +4° and -4°. Results are shown in Table 3.

Table 3 Results

SAMPLE CODE	MATERIAL	LINING COMPOUND	CHUCK ANGLES DRIVE/WALL	PRESSURE
c	0.224 5182	with	43°	4.60 (66.7)
g	0.23 Alulite	with	43°/4°	5.45 (79.0)
h	0.224 5182	with	43°/4°	6.46 (93.6)
j	0.23 Alulite	without	43°/4°	5.91 (85.6)
k	0.244 5182	without	43°/4°	6.18 (89.6)
l	0.23 Alulite	without	43°/-4°	5.38 (77.9)
m	0.25 Alulite	without	43°/-4°	6.20 (89.8)
n	0.23 Alulite	without	43°/0°	6.11 (88.5)
o	0.25 Alulite	without	43°/0°	6.62 (95.9)

ALL PRESSURES IN BAR (PSIG)

ALL CODES

Reform Pad Dia. 47.24mm (1.860") (202 Dia).

6.86mm (0.270") unit Depth h: 2.39mm (0.094") Panel Depth

Table 3 shows Code "O" made from 0.25mm Alulite to give 6.62 bar (95 psi) Pressure Test Result indicating a can end suitable for pressurised beverages. Further chucks with various land lengths (slope) were tried as shown in Table 4.

Table 4

CHUCK WALL ANGLE				
VARIABLE CODE	**43°/0° 1.9mm LAND SHARP TRANSITION**		**43°/0° 1.27MM LAND R. 0.5MM BLEND**	
	NO. D.SEAM RING	WITH D.SEAM RING	NO. D.SEAM RING	WITH D.SEAM RING
7	6.699(97.08)	7.017(101.7)	6.779(98.24)	7.006(101.54)
8	6.315(91.52)	6.521(94.5)	6.293(91.2)	6.236(90.37)
9	6.095(88.33)	6.30(91.3)	6.238(90.4)	6.719(97.38)

ALL PRESSURES IN BAR (PSIG)

CODE

7 = 0.25mm Alulite, 47.24mm (1.860") Reform Pad, 6.86mm (0.270") h_2 Depth, 2.38mm (0.094") Panel; h_1 depth = 2.29mm (0.09")

8 = 0.23mm Alulite, 47.24mm (1.860") Reform Pad, 7.11mm (0.280") h_2 Depth, 2.64mm (0.104") Panel; h_1 depth = 2.54mm (0.10")

9 = 0.23mm Alulite, 47.24mm (1.860") Reform Pad, 7.37mm (0.290") h_2 Depth, 2.90mm (0.114") Panel; h_1 depth = 2.79mm (0.11")

Table 4 shows results of further development to seaming chuck configuration to bring closer the pressure resistance of ring supported and unsupported double seams.

Table 4 identifies parameters for length of generally vertical cylindrical surface 33 on the seaming chuck 30, and also identifies a positional relationship between the chuck wall 24 of the end and the finished double seam. It will be understood from Figure 7 shows that the forces generated by thermal processing or

carbonated products are directed towards and resisted by the strongest portions of the completed double seam.

Table 5 Shows results obtained from a typical seam chuck designed to give double seam in accordance with parameters and relationships identified in Table 4. Typically:- As shown in Figure 8 the chuck comprises a cylindrical land of length 'l' typically 1.9mm (0.075") and frustoconical drive surface 32 inclined at an angle Y°, typically 43°, to the cylindrical to which it is joined by a radius R typically 0.5mm (0.020"). Angle "X" is typically 90°.

<u>**Table 5**</u>

CODE	GAUGE	DIMENSIONS mm		PRESSURE	
		h_2	h_3	bar	(psi)
20	.23mm	7.37 (.290")	2.36 (.093")	6.383	(92.6)
21	.23mm	7.37 (.290")	2.36 (.093") with compound	6.402	(92.8)
26	.23mm	6.87 (.2705")	2.37 (.0935")	6.144	(89.88)
27	.23mm	6.87 (.2705")	2.37 (.0934") with compound	6.071	(88.0)
28	.23mm	7.37 (.290")	2.36 (.093")	6.414	(93.0)
29	.23mm	7.37 (.290")	2.84 (.112")	6.725	(97.5)
30	.23mm	6.86 (.270")	2.37 (.0935")	6.062	(87.9)
31	.23mm	6.86 (.270")	2.37 (.0935")	6.013	(87.2)
34	.25mm	7.37 (.290")	2.87 (.113")	7.787	(112.9)
36	.25mm	7.32 (.288")	2.34 (.092")	7.293	(105.8)
37	.25mm	7.32 (.288")	2.34 (.092") with compound	7.402	(107.3)
38	.25mm	6.87 (.2705")	2.41 (.095")	7.077	(102.6)
516	.25mm	6.35 (.250")	2.34 (.092") with compound	6.937	(100.6)

All variables made from Alulite, 10 Cans per variable.

The can ends may be economically made of thinner metal if pressure retention requirements permit because

these can ends have a relatively small centre panel in a stiffer annulus.

Figure 9 shows a can 12a, closed according to this invention, stacked upon a like can 12b shown sectioned so that stacking of the upper can on the lower can end is achieved by a stand bead 31a of the upper can fits inside the chuck wall 24 of the lower can end with the weight of the upper can resting on the double seam 34 of the lower can end.

The clearance between the bottom of the upper can body and lower can end may be used to accommodate ring pull features (not shown) in the can end or promotional matter such as an coiled straw or indicia.

Using the experimental data presented above, a computer programme was set up to estimate the resistance to deformation available to our can ends when joined to containers containing pressurised beverage. The last two entries on the table relate to a known 206 diameter beverage can end and an estimate of what we think the KRASKA patent teaches.

TABLE 6

END SIZE Bead O:D:ID d_2:d_1	OVERALL DIA d_2 mm	PANEL DIA d_1 mm	RATIO D_2/D_1	CHUCK WALL ANGLE B°	CHUCK WALL LENGTH L mm	RE-ENFORCING RAD r_3 mm	INNER WALL HEIGHT h_3 mm	OUTER WALL HEIGHT h_4 mm	PREDICTED CUT EDGE Ø (* DENOTES ACTUAL)	ACTUAL THICKNESS TO CONTAIN PSI
206-204	64.39 (2.535")	49.49 (1.9485")	1.3010	33.07°	4.22 (0.166")	0.52 (0.0204")	2.34 (0.092")	1.78 (0.070")	75.230 (2.9618")	0.255
206-202	64.39 (2.535")	47.33 [illegible]	1.3604	42.69°	4.95 (0.195")	0.52 (0.0204")	2.34 (0.092")	1.78 (0.070")	74.272 [illegible]*	0.255
206-200	64.39 (2.535")	45.07 (1.7744")	1.4287	50.053°	5.82 (0.229")	0.52 (0.0204")	2.34 (0.092")	1.78 (0.070")	73.713 (2.9021")	0.255
204-202	62.18 (2.448")	47.33 (1.8634")	1.3137	29.78°	3.96 (0.156")	0.52 (0.0204")	2.34 (0.092")	1.78 (0.070")	73.767 (2.9042")	0.24
204-200	62.18 (2.448")	45.07 (1.7744")	1.3796	40.786°	4.70 (0.185")	0.52 (0.0204")	2.34 (0.092")	1.78 (0.070")	72.911 (2.8705")	0.24
202-200	71.98 (2.834")	45.07 (1.7744")	1.597	30.266°	4.09 (0.161")	0.52 (0.0204")	2.34 (0.092")	1.78 (0.070")	71.984 (2.834")	0.225
206 std	64.69 (2.547")	51.92 (2.044")	1.2461	15.488°	4.39 (0.173")	0.56 (0.022")	2.03 (0.080")	-	76.454 (3.010")*	0.28
KRASKA ESTIMATE	64.39 (eg 2.535")	-	-	15°	2.54 (0.100")	0.81 (0.032")	1.65 (0.065")	2.29 (0.090")	78.080 (3.074")	0.292 (0.0115")

All experiments modelled on a notional aluminium alloy of yield strength 310mpa 0.25mm thick. The standard was also 310mpa BUT 0.275mm thick.